UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office
Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.
08/856,116	05/14/97	CHEN F	AMAT/1931

MM21/0303

PATENE COUNSEL
APPLIED MATERIALS INC
P O BOX 450 A
SANTA CLARA CA 95052

EXAMINER	
SOUW, B	
ART UNIT	**PAPER NUMBER**
2814	

DATE MAILED: 03/03/99

Please find below and/or attached an Office communication concerning this application or proceeding.

Commissioner of Patents and Trademarks

Office Action Summary	Application No. 08/856,116	Applicant(s) Chen et al.
	Examiner Bernard Souw	Group Art Unit 2814

☒ Responsive to communication(s) filed on *May 14, 1997* .

☐ This action is **FINAL**.

☐ Since this application is in condition for allowance except for formal matters, **prosecution as to the merits is closed** in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11; 453 O.G. 213.

A shortened statutory period for response to this action is set to expire *3* month(s), or thirty days, whichever is longer, from the mailing date of this communication. Failure to respond within the period for response will cause the application to become abandoned. (35 U.S.C. § 133). Extensions of time may be obtained under the provisions of 37 CFR 1.136(a).

Disposition of Claims

☒ Claim(s) *1-20* is/are pending in the application.

Of the above, claim(s) *19* is/are withdrawn from consideration.

☐ Claim(s) _____ is/are allowed.

☒ Claim(s) *1-12, 15-18, and 20* is/are rejected.

☒ Claim(s) *13 and 14* is/are objected to.

☐ Claims _____ are subject to restriction or election requirement.

Application Papers

☐ See the attached Notice of Draftsperson's Patent Drawing Review, PTO-948.

☒ The drawing(s) filed on *May 14, 1997* is/are objected to by the Examiner.

☐ The proposed drawing correction, filed on _____ is ☐approved ☐disapproved.

☒ The specification is objected to by the Examiner.

☒ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. § 119

☐ Acknowledgement is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d).

☐ All ☐ Some* ☐ None of the CERTIFIED copies of the priority documents have been

☐ received.

☐ received in Application No. (Series Code/Serial Number) _____ .

☐ received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

*Certified copies not received: _____ .

☐ Acknowledgement is made of a claim for domestic priority under 35 U.S.C. § 119(e).

Attachment(s)

☒ Notice of References Cited, PTO-892

☒ Information Disclosure Statement(s), PTO-1449, Paper No(s). *2*

☐ Interview Summary, PTO-413

☐ Notice of Draftsperson's Patent Drawing Review, PTO-948

☐ Notice of Informal Patent Application, PTO-152

--- SEE OFFICE ACTION ON THE FOLLOWING PAGES ---

DETAILED ACTION

1. The name Roderick Craig Mosely is neither included in the formal list of inventors, nor in the Declaration. Consequenly, the name is not being considered for the present application.

2. During a telephone conversation with Mr. B. Todd Patterson on 02-12-99 a provisional election was made with traverse to prosecute the invention of a Method of Making a Semiconductor Device, claims 1-18 and 20. Affirmation of this election must be made by applicant in replying to this Office action. Claim 19 is withdrawn from further consideration by the examiner, 37 CFR 1.142(b), as being drawn to a non-elected invention.

3. This application has been filed with informal drawings which are acceptable for examination purposes only. Formal drawings will be required when the application is allowed.

4. The drawings are objected to as failing to comply with 37 CFR 1.84(p)(5) because they include the following reference sign(s) not mentioned in the description:

a) Fig. 11 is not addressed by the specification

b) Fig. 12: The portion of the barrier layer 30 on the bottom of the plug 20 should have been removed by previous etching, as depicted in Fig. 10 and Fig. 11

c) Fig. 15: Label 68 should be labeled 58 (magnets), in order to conform with the specification

d) Fig. 17: Labels 152, 154, 156, 158 and 160 are not addressed by the specification

Corrections are required.

5. The disclosure is objected to because of the following informalities:

a) The specification does not address Fig. 11

b) The specification does not discuss labels 152, 154, 156, 158 and 160 of Fig. 17

Appropriate corrections are required.

6. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless --
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 1-4,8,15-18 and 20 are rejected under 35 U.S.C. 102(b) as being clearly anticipated by Taguchi et al.

Specifically, the limitation of claim 1 step a is disclosed by Taguchi et al. as shown in column 5,lines 4-6; claim 1 step b as shown in column 5,lines 11-19,and claim 1 steps c and d as shown in column 5, lines 20-23.

The limitation of claim 2 is disclosed by Taguchi et al. as shown in column 5,lines 4-6; claims 3 and 8 as shown in column 5,line 4; and claim 4 as shown in column 5,lines 11-19.

The limitations of claim 15 step a is disclosed by Taguchi et al. as shown in column 7,lines 32-36; claim 15 step b as shown in column 7,lines 39-42; claim 15 step c as shown in column 7,lines 43-45; claim 15 step d as shown in column 7,lines 48-50, and claim 15 step e as shown in column 7,lines 59-61.

The limitations regarding the two barrier layers recited in claim 16 are disclosed by Taguchi et al. as shown in column 7,lines 34-36 and lines 43-45, respectively; those of claim 17 as shown in column 7,lines 36-38 and lines 45-47, respectively.

Claim 18 is disclosed by Taguchi et al. as shown in column 7,lines 50-52

7. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 5 and 6 are rejected under 35 U.S.C. 103(a) as being unpatentable over Taguchi et al. in view of Ho et al.

Taguchi et al. describe a method of filling interconnect holes through a dielectric layer in an integrated circuit, comprising steps that show all the limitations of claims 5 and 6, except the recitations that the metal layer deposited in the hole is copper, and that the deposition is conducted by the chemical vapor deposition (CVD) method.

Ho et al. disclose an invention of filling such a through hole with copper (column 3, lines 6-8) using the CVD method (column 3, lines 33-35).

It would have been obvious to a person having ordinary skill in the art at the time of the invention to modify Taguchi's method by Ho's, i.e., filling the hole with copper, instead of Al-1%Si. Copper is a material better than Al-1%Si for interconnect lines owing to its higher electrical conductivity and its resistance to electromigration and hillock formation.

8. Claim 7 is rejected under 35 U.S.C. 103(a) as being unpatentable over Taguchi et al. in view of Barnes et al.

Taguchi et al. describe a method of filling interconnect holes through a dielectric layer in an integrated circuit, comprising steps that show all the limitations of claim 7, except the recitations that the metal layer deposited in the hole is copper, and that the deposition is conducted by the physical vapor deposition (PVD) method.

Barnes et al. disclose an apparatus for depositing materials, including copper, into holes having high aspect ratios (column 4, line 4). Barnes's apparatus as depicted in Fig. 1 uses sputter targets (12) made of the material to be deposited on the substrate (column 4, lines 2-4). Since Barnes's method deposits atoms (or ions) on a substrate in the same, unchanged chemical form, either with or without a plasma it clearly matches the definition of a Physical Vapor Deposition (PVD).

It would have been obvious to one with ordinary skill in the art at the time of the invention to modify Taguchi's method by Barnes's, i.e., depositing copper by PVD instead of CVD, since the

PVD does not make use of any chemical reaction and is therefore free from residues that may contaminate and harm the product.

9. Claim 9 is rejected under 35 U.S.C. 103(a) as being unpatentable over Taguchi et al. in view of Ho et al.

Taguchi et al. describe a method of filling interconnect holes through a dielectric layer in an integrated circuit, comprising steps that show all the limitations of claim 9, except the recitation that the second barrier layer comprises a material selected from the group consisting of Ta, TaN, etc.

Ho et al. include tantalum (Ta) in the group of materials used for their (second) barrier (column 10, lines 40-48).

It would have been obvious to a person having ordinary skill in the art at the time of the invention to modify Taguchi's method by Ho's, i.e., depositing tantalum as a barrier metal, since Ta satisfies all the requirements for a second barrier layer, and is known as a standard sputtering target material with a good sputtering yield (see below).

10. Claims 10-12 are rejected under 35 U.S.C. 103(a) as being unpatentable over Taguchi et al. in view of Ho et al. as applied to claim 9 above, and further in view of Barnes et al. and Bunshah.

Taguchi et al. in view of Ho et al. show all the limitations of claims 10-12, except the recitations of using copper as hole-filling material, and depositing the copper layer and the second barrier layer by a sputtering method under the conditions of a high density plasma.

Barnes's hole-filling materials include copper (column 4, line 4), which is deposited by a sputtering method under the conditions of a high density plasma (column 6, lines 49-53 and lines 63-67), thus anticipating claims 10 and 12. Bunshah teaches that both copper and tantalum are good sputtering targets (see Bunshah, Table 5-1 on page 261), thus obviating claim 11 (and also claim 10).

It would have been obvious to one with ordinary skill in the art at the time of the invention to apply Taguchi's method as modified by Ho et al. to use tantalum as a second barrier metal, and further modify by Barnes et al. to sputter-deposit copper under the conditions of a dense plasma, while also using tantalum as a sputtering target according to Bunshah's teaching for forming the second barrier layer. The benefits of using copper and tantalum have been previously discussed in regard of claims 6 and 9. To sputter- deposit under the conditions of a dense plasma would be desirable, owing to the increased deposition rate and the superior properties of the sputter grown films (Barnes et al., column 6, lines 67-68 and column 7, lines 1-5).

11. The specification is objected to as failing to provide proper antecedent basis for the claimed subject matter. See 37 CFR 1.75(d)(1) and MPEP § 608.01(o). Correction of the following is required: The specifications does not adequately discuss the reasons, the means, and the intended results for the process steps of heating the substrate to a temperature of less than 500 ^{0}C and its subsequent subjection to a pressurized environment of about 1000 psi to 100,000 psi, as recited in claims 13 and 14.

Papers related to this application may be submitted directly to Art Unit 2814 by facsimile transmission. Papers should be faxed to Art Unit 2814 via the Technology Center 2800 fax center located in Crystal Plaza 4, room 4C23. The faxing of such papers must conform with the notice published in the Official Gazette, 1096 OG 30 (15 November 1989).

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Bernard E. Souw whose telephone number is (703) 305-3303. The examiner can normally be reached on Monday-Friday from 8:30 am to 5:00 pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Olik Chaudury, can be reached on (703) 305-2794. The fax number for the organization where this application or proceeding is assigned is (703) 308-7722 or -7724.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the Technology Center receptionist at (703) 308-0956.

Olik Chaudhuri
Supervisory Patent Examiner
Technology Center 2800

Bernard E. Souw

February 12, 1999